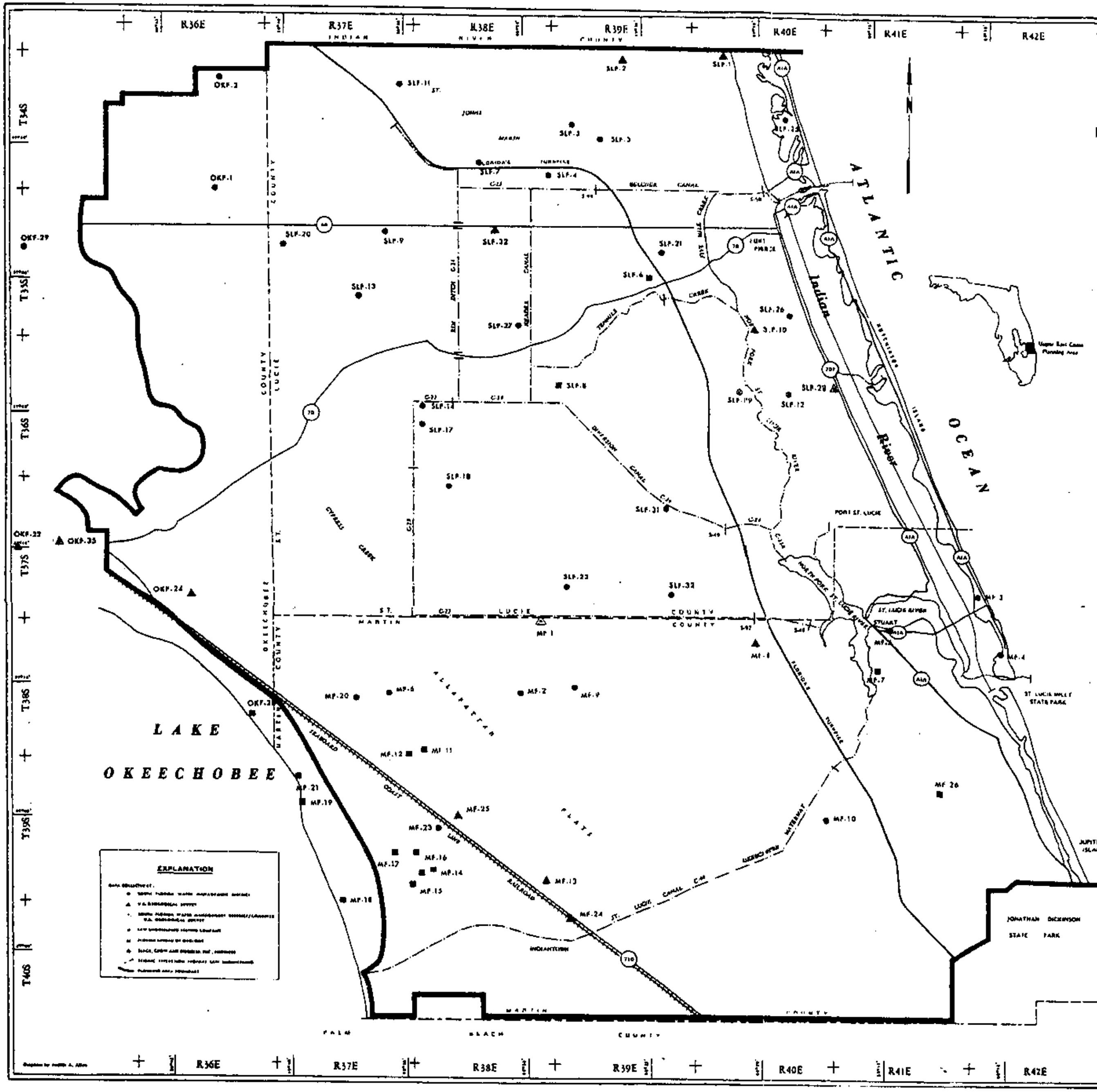
DRE-94

Tech Map Series 79-1; Hydrogeologic Reconnaissance of the Floridan Aquifer System Upper East Coast Planning Area

Brown, Reese



FLORIDAN AQUIFER SYSTEM WELL LOCATION MAP

UPPER EAST COAST PLANNING AREA

By:

Michael F. Brown and Dennis C. Reese

Prepared By:

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

1979

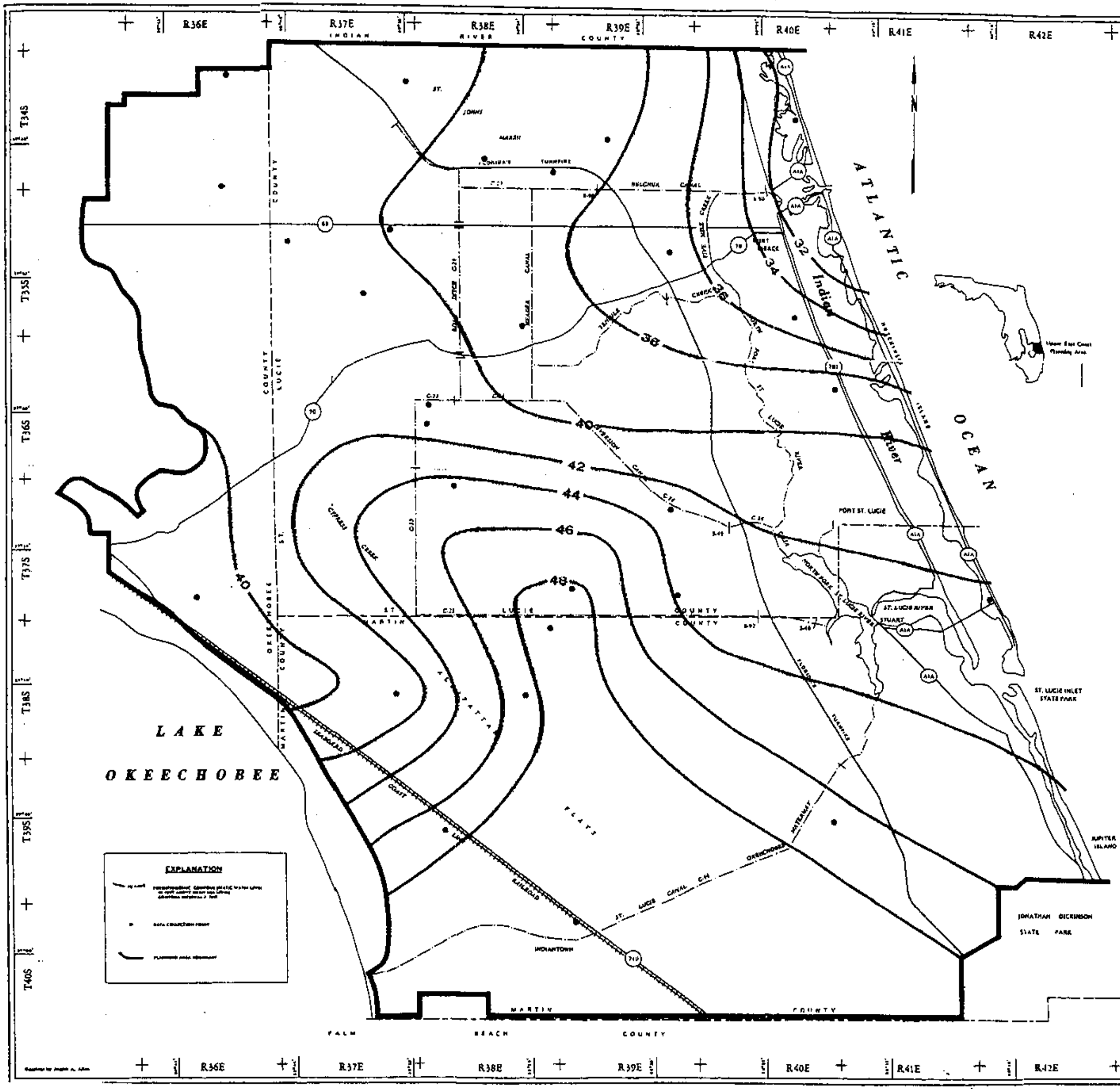
INTRODUCTION

METHODOLOGY

ACKNOWLEDGEMENTS

SELECTED REFERENCES

DRE 94



POTENTIOMETRIC SURFACE MAP OF THE FLORIDAN AQUIFER SYSTEM DURING SEPTEMBER 1977 UPPER EAST COAST PLANNING AREA

By:

Michael P. Brown and Dennis E. Reece

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SOUTH FLORIDA WATER MANAGEMENT DISTRICT

1979

INTRODUCTION

A potentiometric map is a graphic representation of an imaginary surface that depicts the pressure head of water confined in an artesian aquifer. Stringfield (1936) prepared the first potentiometric map of the Floridan aquifer covering Florida from the Suwannee River to the Florida Keys. Healy (1962) produced the first potentiometric map for the entire state. Water within the Floridan aquifer system in the Upper East Coast Planning Area (UECPA) is held at greater than atmospheric pressure by overlying confining beds. Wells drilled into any of the Floridan aquifer system producing zones as defined in this study area will flow freely to the surface without the aid of pumps. Under a static head of approximately 14.7 ft. above land surface, discharge as high as 1650 gallons per minute (gpm) was recorded from a 10-inch diameter well penetrating producing zones 1, 2 and 3. Flows throughout the area generally range between 200 and 600 gpm from wells having diameters from 6 to 12 inches. Data presented on this map were collected during September 1977, and reflect the area's highest observed water levels in the Floridan aquifer system for this year.

DATA COLLECTION AND REDUCTION

Shut-in pressures in the aquifer were measured with a calibrated mechanical pressure gauge read to the nearest tenth of head above the measuring point. Measuring points for each well were referenced to mean sea level (msl) by a leveling survey. Pressure measurements were made at all wells in the network within a five-day period on a monthly frequency during 1977 and bimonthly during 1978. Within the study area wellhead pressures were observed to be influenced by changes in water density in the upper 50 to 100 ft. of borehole where the well casing was in contact with cooler shallow groundwater, thus having the effect of lowering wellhead pressure. To compensate for this lower apparent pressure, all wells were discharged to a steady state temperature. The well was then shut-in at which time wellhead pressures were monitored with the final pressure being recorded after the well stabilized. In the preparation of this map an additional correction was made because large areal changes in both water quality and temperature influenced the pressure head. Specific gravity data collected concurrent with pressure measurements were used along with the height of water column above the top of the Floridan to correct all pressure head data to a constant freshwater specific gravity of 1.000.

POTENTIOMETRIC SURFACE

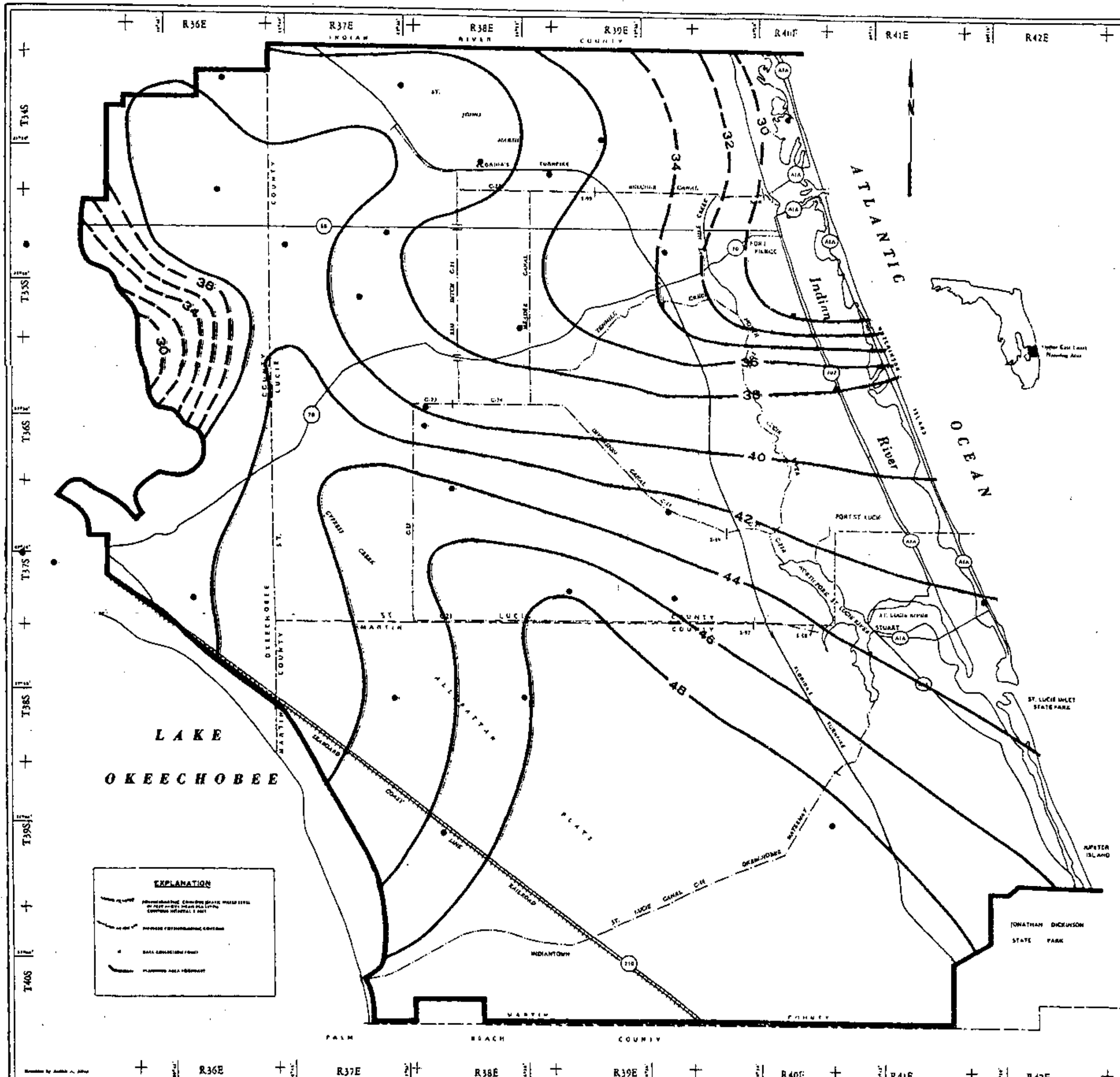
Water stored in the Floridan aquifer system in the UECPA exists in a dynamic state in which hydraulic gradients are controlled by recharge, discharge and aquifer properties. Because groundwater flows down gradient from areas of higher to lower heads, and perpendicular to lines of equal potential, one can observe on the potentiometric map that much of the water enters the planning area from the south. The potentiometric surface in the UECPA ranges from a high of +49 ft. msl in north-central Martin County to a low of +31.0 ft. msl in northeast St. Lucie County near the Ft. Pierce Inlet.

REFERENCES

Healy, Henry G., 1962, Piezometric Surface and Areas of Artesian Flow of the Floridan Aquifer, July 7-16, 1961: Florida Geological Survey, Map Series 4.

Stringfield, V.T., 1936, Artesian Water in the Florida Peninsula: U.S. Geological Survey, Water-Supply Paper 773-C.

POTENTIOMETRIC SURFACE MAP OF THE FLORIDAN AQUIFER SYSTEM DURING MAY 1978 UPPER EAST COAST PLANNING AREA



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1979

INTRODUCTION

[illegible]

DATA COLLECTION AND REDUCTION

[illegible]

POTENTIOMETRIC SURFACE

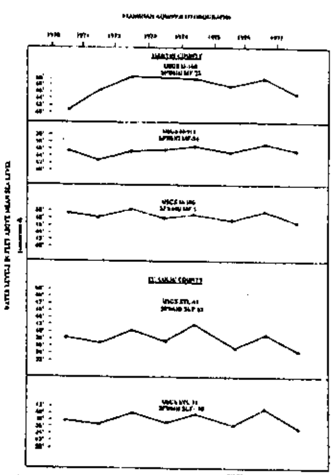
[illegible]

REFERENCES

Healy, Henry G., 1962. Piezometric Surface and Areas of Artesian Flow of the Floridan Aquifer, July 7-16, 1961. Florida Geological Survey, Map Series 4.

Stringfield, V.T., 1936. Artesian Water in the Florida Peninsula: U.S. Geological Survey, Water-Supply Paper 773-C.

U.S. Geological Survey, 1977. Hydrographic Data Collected in St. Lucie and Martin Counties, Florida. Personal Communication, Miami Sub-District Office.



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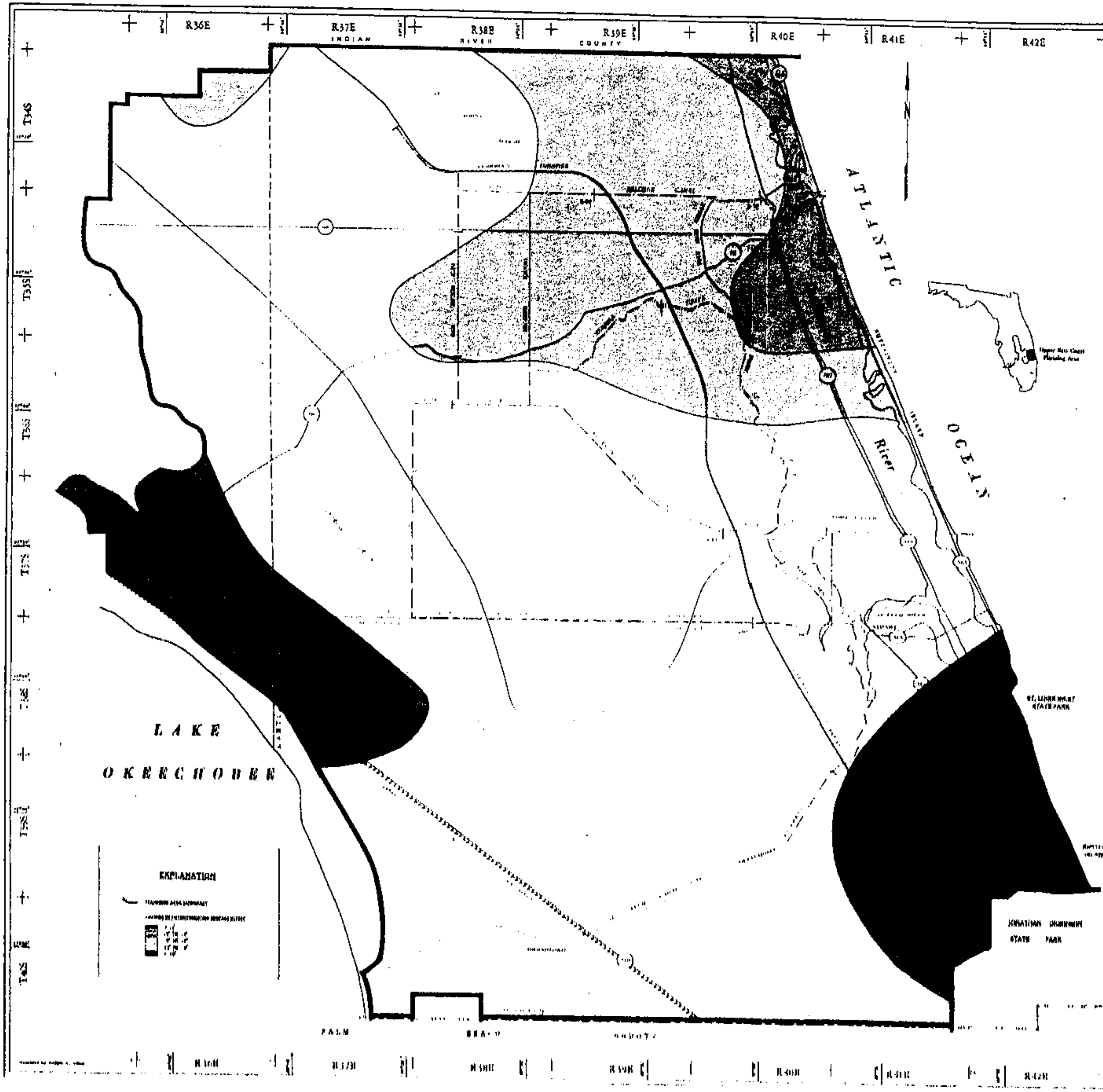

DIFFERENCE IN POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER SYSTEM BETWEEN SEPTEMBER 1977 AND MAY 1978 UPPER EAST COAST PLANNING AREA

By:

Prepared By:

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

INTRODUCTION

[illegible]

DATA ASSUMPTION

[illegible]

DIFFERENCE IN POTENTIOMETRIC SURFACE

[illegible]

REFERENCES

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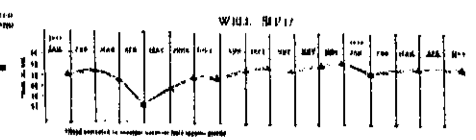

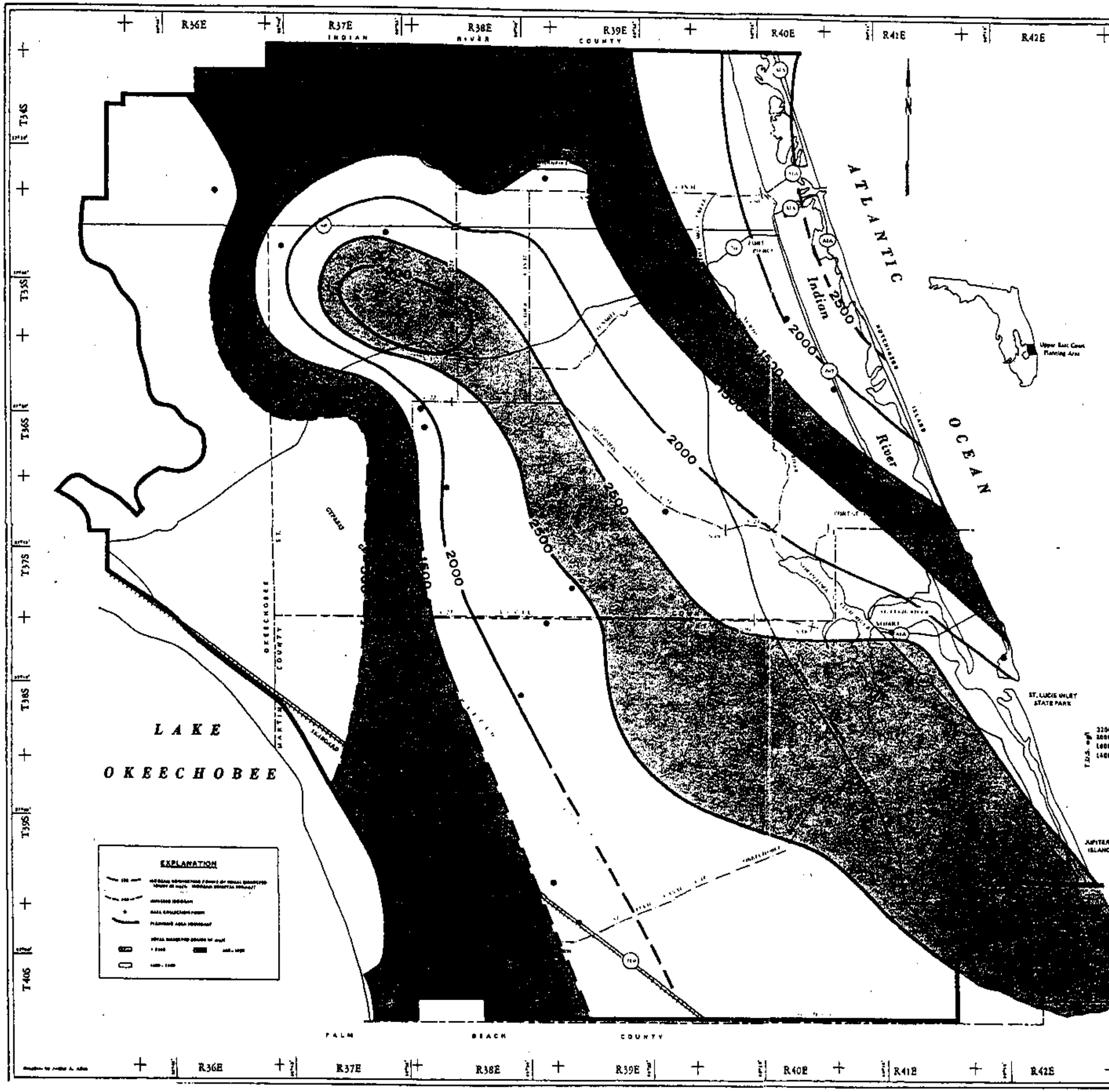

TOTAL DISSOLVED SOLIDS OF FLORIDAN AQUIFER SYSTEM WATERS FOR SEPTEMBER 1977

UPPER EAST COAST PLANNING AREA

by:

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SOUTH FLORIDA WATER MANAGEMENT DISTRICT

1979

INTRODUCTION

Total dissolved solids (TDS) content of a water sample is a measure of mineral and organic matter that remains after the sample is filtered and evaporated to dryness. The degree of salinity, as measured by TDS, may be classified as follows (Swenson, et al., 1965):

TOTAL DISSOLVED SOLIDS (MG/L)	DEGREE OF SALINITY
less than 1,000	non-saline
1,000 to 3,000	slightly saline
3,000 to 10,000	moderately saline
10,000 to 35,000	very saline
more than 35,000	brine

High TDS values indicate that specific substances may be present in concentrations which limit the suitability of the water for various uses. The U.S. Environmental Protection Agency (E.P.A.) recommends a maximum value of 500 mg/l TDS for potable water when alternate water supplies of lower TDS are available (U.S. E.P.A., 1979).

Areal variations in TDS of composite samples of the upper three producing zones of the Floridan aquifer system collected under natural discharge conditions are denoted on the map by isograms.

DATA COLLECTION

Water samples were collected on a monthly basis from 16 network monitor wells during 1977 and bimonthly during 1978. Wellhead samples were taken after the wells had discharged to steady-state borehole temperatures. This procedure assured complete flushing of the borehole and provided consistent sampling during the study. Temperature, specific gravity, specific conductance, pH, and alkalinity were measured immediately after sampling. One liter samples were collected for complete laboratory analysis of inorganic constituents. Total dissolved solids were analyzed by the gravimetric method with drying at 180°C.

GENERAL INTERPRETATIONS

The TDS content varies areally and vertically in the Floridan aquifer system. Total dissolved solids are relatively high in waters of the Floridan aquifer system in the Upper East Coast Planning Area (UECPA) due to the presence of highly mineralized water trapped in sediments during an earlier geologic time.

Chloride is the predominant anion with lesser amounts of sulfate, bicarbonate, and sulfide also present. Sodium, calcium, and magnesium are the major cations in association with minor amounts of potassium and strontium. Other ions are generally present in only trace amounts. The TDS values in the UECPA for September 1977, range from 3300 mg/l in northwestern St. Lucie County to 900 mg/l in eastern Okeechobee County and western Martin County. Overall distribution of TDS values in the Floridan aquifer system is similar to that of chloride concentrations.

Monthly samples did not show any significant change in TDS values throughout the UECPA during 1977 and 1978. Bimonthly fluctuations of TDS values for individual wells may be due to differing flow contributions of the various producing zones which result from head changes within these zones. A plot of TDS values of well SLF-17 during a seventeen month period is shown below.

Three of the monitor wells used in this study were also sampled by Lichtler in 1957 and 1958 (Lichtler, 1960). The following table compares TDS values of the wells during 1957 and 1977:

Well	TDS(MG/L)* 1957-1958	Average TDS (MG/L) 1977-1978
MF-1	2560.	2510.
MF-4	880.	1000.
MF-10	3050.	2300.

*Data from Lichtler, 1960.

The TDS values of water from the Floridan aquifer system in the UECPA do not appear to have changed significantly in the last twenty years.

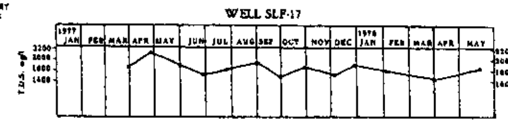
REFERENCES

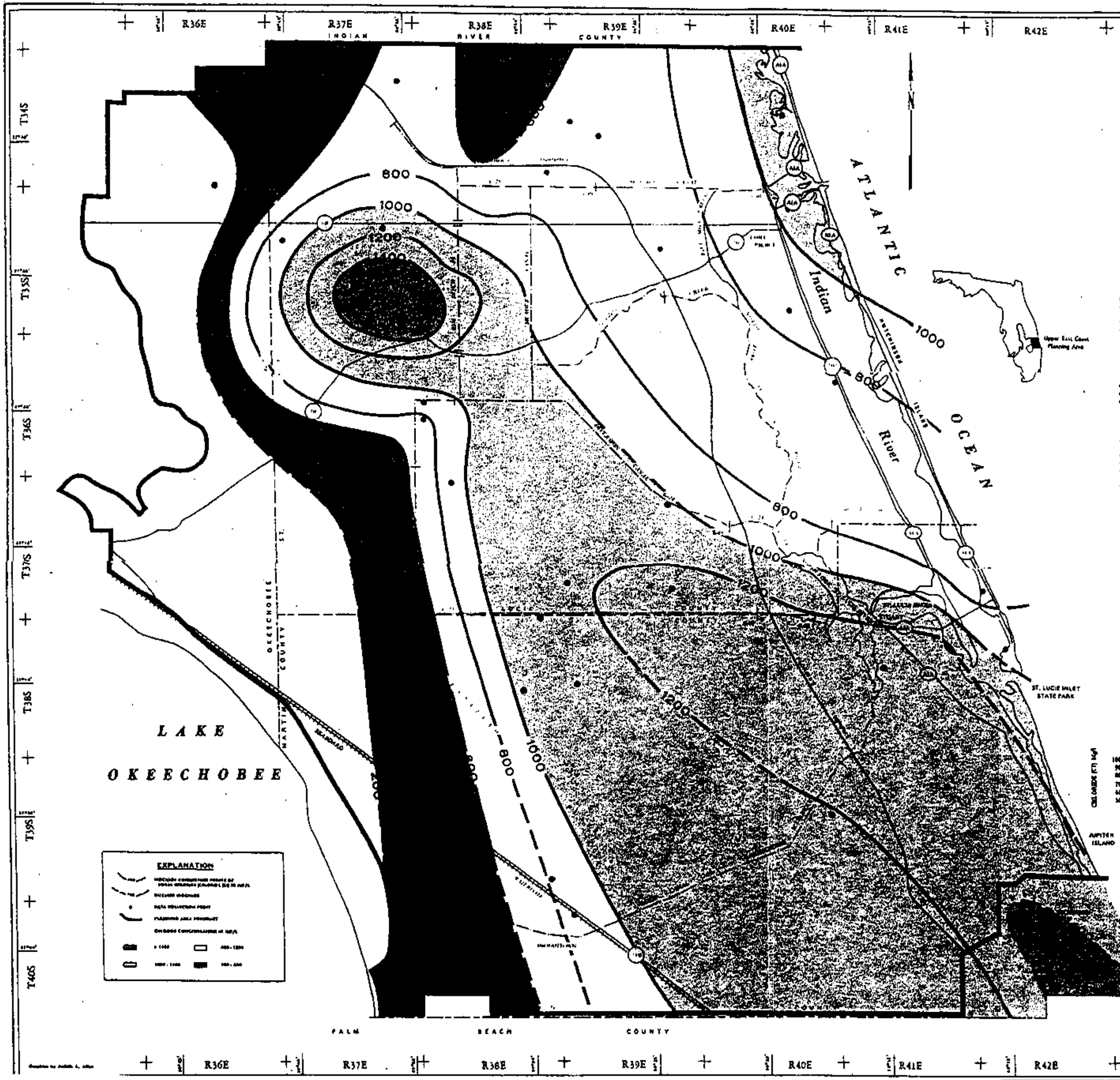
Lichtler, W.F., 1960. Geology and Groundwater Resources of Martin County, Florida, Florida Bureau of Geology, RI No. 23.

Swenson, and Baldwin, 1965, A Primer on Water Quality, U.S. Geological Survey, Circular.

U.S. E.P.A., 1979, National Secondary Drinking Water Regulations, Federal Register, Vol. 44, No. 140, July 19, 1979.

WELL SLF-17





CHLORIDE CONCENTRATION OF FLORIDAN AQUIFER SYSTEM WATERS FOR SEPTEMBER 1977 UPPER EAST COAST PLANNING AREA

By:

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Prepared By:

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

1979

INTRODUCTION

The chloride concentration of water within the Floridan aquifer in the Upper East Coast Planning Area (UECPA) is an important limiting factor in its use. Maximum recommended chloride concentration, as chloride ion, for potable water is 250 mg/l (U.S. E.P.A., 1979). Crop tolerances of chlorides in agricultural irrigation water vary depending on: (1) type of crop, (2) irrigation methods, and (3) management practices. For example, relatively high chloride concentrations can be tolerated in water used for flood irrigation of citrus but not in water used for spray irrigation (Calvert and Reitz, 1965).

Areal variations in the composite chloride concentration of the upper three producing zones of the Floridan aquifer system in the UECPA during September 1977 are represented on the map by isochlors.

DATA COLLECTION

Water samples were collected on a monthly basis from all network monitor wells during 1977 and bimonthly during 1978. Wellhead samples were taken only after wells had discharged to steady-state borehole temperatures. This procedure assured complete flushing of the borehole and provided consistent sampling during the study. Temperature, specific gravity, specific conductance, pH, and alkalinity were measured on site immediately after sampling. One liter samples were collected for complete laboratory analysis of inorganic constituents.

GENERAL INTERPRETATIONS

Chloride concentrations vary both areally and vertically in the Floridan aquifer system. High chloride concentrations in the Floridan aquifer system of the UECPA are due to the presence of highly mineralized water trapped in the sediments during an earlier geologic time and not recent day salt water intrusion from the Atlantic Ocean. Salt water intrusion of the Floridan aquifer system is not hydraulically possible in the UECPA due to high potentiometric heads of the Floridan aquifer system along the coast.

A "ridge" of relatively poor quality water having a chloride concentration ranging from 1200 to 1400 mg/l strikes northwest-southeast across the UECPA. Fresher water parallels this ridge on both sides with chloride concentrations as low as 200-400 mg/l occurring in western Martin and St. Lucie counties. Insufficient data is available to define the chloride concentration of the upper three producing zones of the Floridan aquifer system along the western boundary of the UECPA.

Results of monthly sampling showed that there were no significant temporal changes in chloride concentration throughout the year. Monthly fluctuations of chloride concentration for individual wells may be due to differing flow contributions of the various producing zones which result from head changes within the zones. Chloride concentration during the seventeen month period is shown below for well SLF-17, located in east-central St. Lucie County. The chloride concentration for this well ranged from a low of 525 mg/l in early March 1977, to a high of 930 mg/l in late April 1977. The chloride concentration averaged 680 mg/l for this well and, except for March to April 1977, fluctuated by only 150 mg/l during the sampling period.

Two previous investigations examined chloride concentrations of artesian wells within the UECPA. A study of 49 artesian wells in St. Lucie County concluded that no significant increase in chloride concentrations occurred, between 1950 and 1963 (Calvert, et al., 1965). Another study sampled artesian wells in Martin County during 1957 and 1958 (Lichtler, 1960). Three of these wells were also sampled during 1977-1978 by the SFWMD study. The following table compares the chloride concentrations of these wells during 1957 and 1977-1978.

Well No.	Chloride Concentration	Average Chloride Concentration
	1957* (MG/L)	1977-1978 (MG/L)
MF-1	1150.	1140.
MF-4	350.	320.
MF-10	1180.	1110.

*data from Lichtler, 1960.

It is apparent that chloride concentrations of the Floridan aquifer system in the UECPA have not significantly changed in the last 20 years.

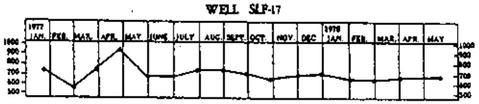
REFERENCES

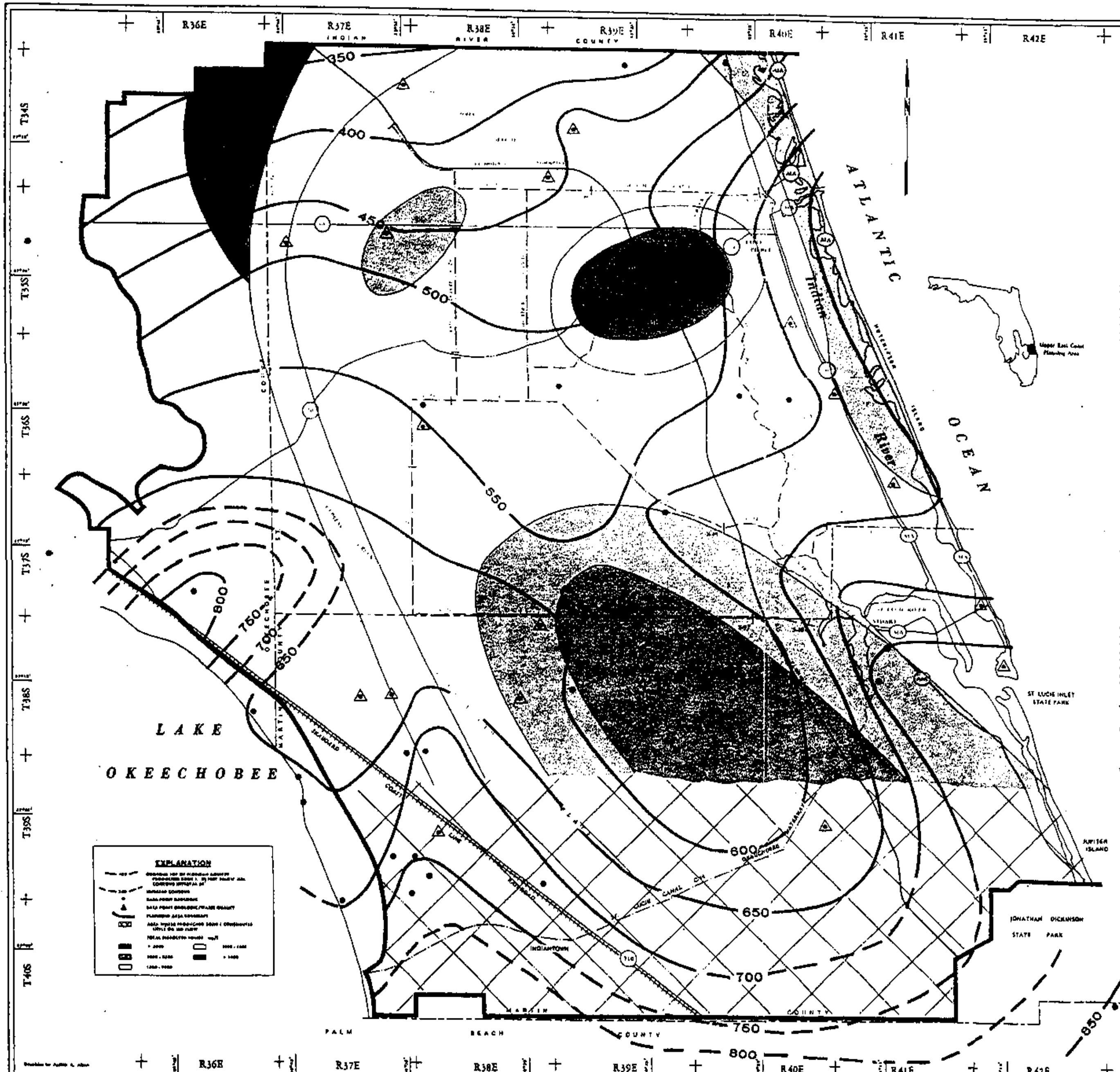
Calvert, D.V., and Reitz, H.J., 1965. Salinity of Water for Sprinkler Irrigation of Citrus, Proceedings of the Florida State Horticultural Society, Volume 78.

Lichtler, W.F., 1960. Geology and Groundwater Resources of Martin County, Florida, Florida Bureau of Geology, RI No. 23.

U.S. E.P.A., 1979. National Secondary Drinking Water Regulations, Federal Register, Vol. 44, No. 140, July 19, 1979.

WELL SLP-17





TOP OF FLORIDAN AQUIFER SYSTEM PRODUCING ZONE 1 AND ACCOMPANYING WATER QUALITY UPPER EAST COAST PLANNING AREA

By
Michael P. Brown and Dennis C. Reese

Prepared By

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

1979

INTRODUCTION

Throughout the Upper East Coast Planning Area (UECPA) contributing intervals within the Floridan aquifer system were found to be stratigraphically confined to unique rock units with the percent water contribution to the open borehole varying greatly. In the UECPA the Floridan aquifer system consists of a number of producing zones of different hydrologic properties separated by semi-permeable zones in a sequence of lower Oligocene, upper and middle Eocene limestones. The base of the Floridan aquifer system could not be defined because the total depths of wells used for data collection limited depth of exploration.

METHODOLOGY

Data collected in the compilation of this map include geologic descriptions of well cuttings from [illegible] wells and borehole geophysical logs from 38 wells. Twenty-two geologic logs collected from other agencies were also consulted.

Borehole geophysical surveys used to determine contributing intervals in the open borehole include borehole fluid resistivity/temperature logs collected from 24 wells and corrected flow meter logs calculated from 17 wells. Natural gamma ray, neutron porosity and electric logs were used to tie the geology and stratigraphy to these intervals within the Floridan aquifer system.

The water quality observed at the wellhead of a Floridan well in the UECPA is a composite of the [illegible] water quality of the various producing zones penetrated by the open portion of the borehole. Borehole geophysical methods were used to determine flow and water quality in the borehole. A mass balance technique requiring borehole flow and borehole water quality above and below a producing zone was used to estimate total dissolved solids (TDS) of the water in each producing zone. [illegible]

$Q = Av$

Where,

Q = flow [illegible]

A = area [illegible]

v = velocity [illegible]

[illegible]

Fluid resistivity logs were used to estimate borehole water quality for most wells.

[illegible]

$C = \frac{10{,}000}{R}$

Where,

C = specific conductance in micromhos/cm

R = fluid resistivity in ohm meters

Fluid resistivity data used in this study were compensated for fluid temperature at 25°C.

Wellhead water sample analyses from all monitoring wells were used to calculate the following regression equation for TDS and specific conductance.

$TDS = .631 \times C + 31.5$

Where,

TDS = total dissolved solids (in mg/l)

[illegible]

The following mass balance equation was used to estimate TDS values for the water of each producing zone.

$$TDS_{zone} = \frac{Q_A TDS_A - Q_B TDS_B}{(Q_A - Q_B)}$$

Where,

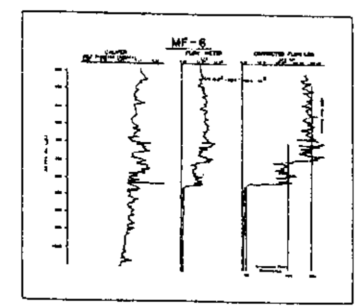
Q_A + TDS_A [illegible]

Q_B + TDS_B [illegible]

[illegible]

GENERAL INTERPRETATION

[illegible]



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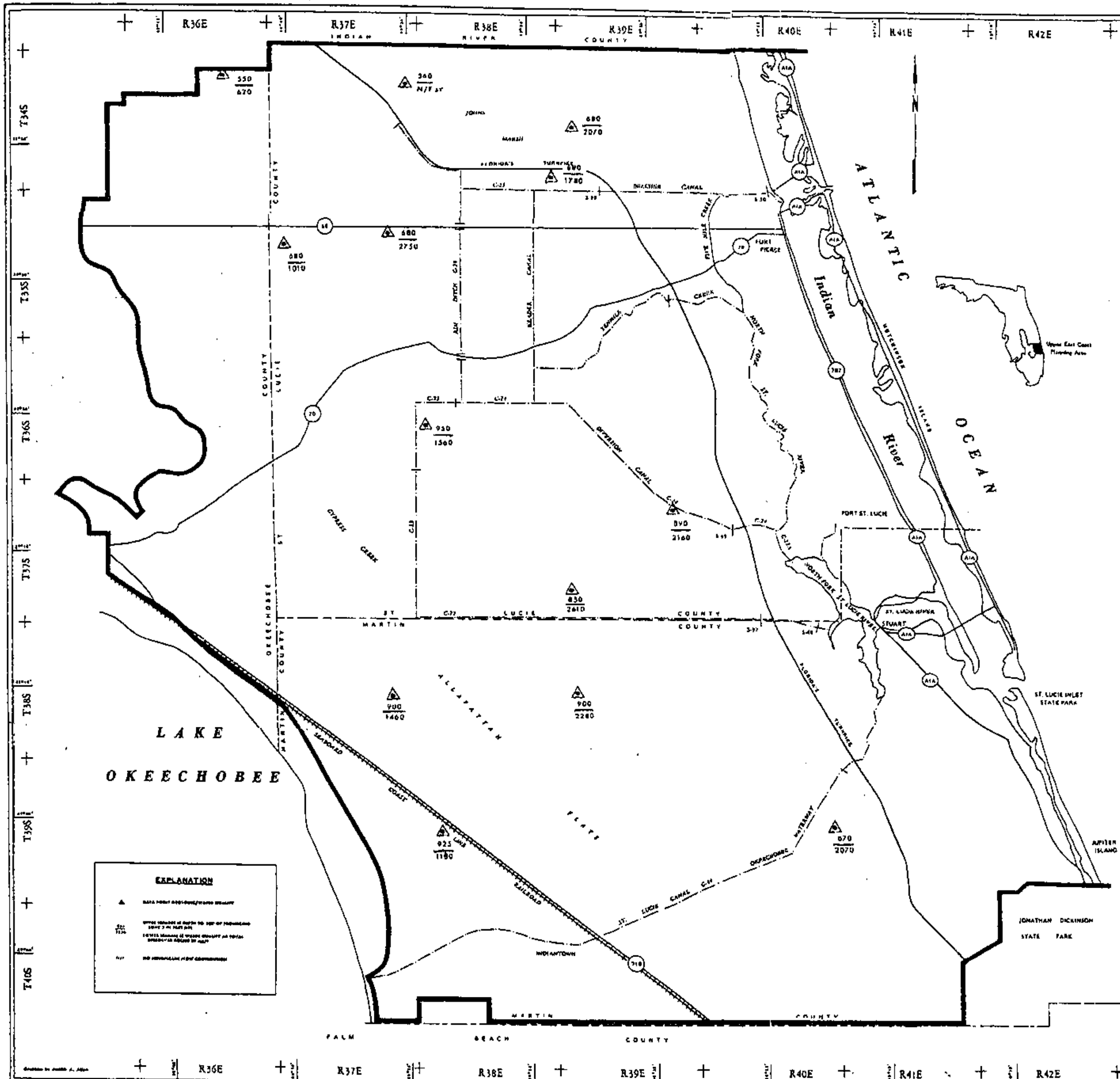

TOP OF PRODUCING ZONE 3 AND ACCOMPANYING WATER QUALITY FLORIDAN AQUIFER SYSTEM UPPER EAST COAST PLANNING AREA

By:
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SOUTH FLORIDA WATER MANAGEMENT DISTRICT

1979

INTRODUCTION

Throughout the Upper East Coast Planning Area (UECPA) contributing intervals within the Floridan aquifer system were found to be stratigraphically confined to unique rock units with the percent water contribution to the open borehole varying areally. In the UECPA the Floridan aquifer system consists of a number of producing zones of different hydrologic properties separated by semi-permeable zones in a sequence of Lower Oligocene, Upper and Middle Eocene formations. The base of the Floridan aquifer system could not be defined because the total depths of wells used for data collection limited depth of exploration.

METHODOLOGY

Data collected in the compilation of this map include geologic descriptions of well cuttings from three control wells and borehole geophysical logs from 13 wells.

Borehole geophysical surveys used to determine contributing intervals in the open borehole include borehole fluid resistivity/temperature logs and corrected flow meter logs. Natural gamma ray, neutron porosity and electric logs were used to tie the geology and stratigraphy to these intervals within the Floridan aquifer system.

The water quality measured at the wellhead of a Floridan well in the UECPA is a composite of the [illegible] water quality of the various producing zones penetrated by the open portion of the borehole. Borehole geophysical methods were used to determine flow and water quality in the borehole. A mass balance technique requiring borehole flow and borehole water quality above and below a producing zone was used to estimate total dissolved solids (TDS) of the water in each producing zone. Relative borehole flow at any point in the well was calculated from the flow meter log and the caliper log in the following manner.

$$Q = Av$$

Where,

Q = flow (in relative units of $cps\cdot in^2$) in the borehole.
A = area (in^2) of the borehole assuming circular borehole conditions.
v = velocity (cps) of the borehole fluid.

Corrected flow logs were computed at constant depth intervals of two feet. A typical caliper log, flow meter log, and computed flow log are shown below. A best fit line is drawn through constant flow portions of the flow log. Where a producing zone contributes water, the flow increases reflecting the cumulative flow of all producing zones below the point of measurement. The relative flow contribution of each producing zone is the ratio of the difference in flow across the producing zone to the total flow of the well.

Fluid resistivity logs were used to estimate borehole water quality for most wells.

Fluid resistivity is related to specific conductance by the following equation.

$$C = \frac{10{,}000}{R}$$

Where,

C = specific conductance in micromhos/cm
R = fluid resistivity in ohm-meters

Fluid resistivity data used in this study were compensated for fluid temperature at 25°C.

Wellhead water sample analyses from all monitoring wells were used to calculate the following regression equation for TDS and specific conductance:

$$TDS = .631 \times C + 57.5$$

Where,

TDS = total dissolved solids in mg/l

A linear correlation coefficient of 0.97 was found for TDS and specific conductance.

The following mass balance equation was used to estimate TDS values for the water of each producing zone.

$$TDS_{zone} = \frac{Q_A TDS_A - Q_B TDS_B}{(Q_A - Q_B)}$$

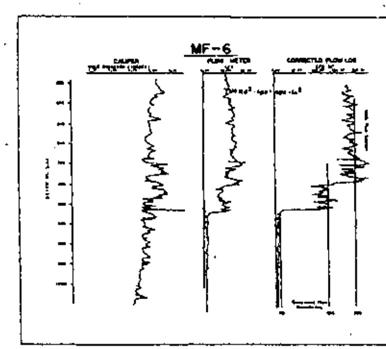
Where,

Q_A + TDS_A are the borehole flow and borehole fluid TDS values, respectively, above the producing zone.
Q_B + TDS_B are the borehole flow and borehole fluid TDS values, respectively, below the producing zone.

Tops and bottoms of each producing zone were defined by geologic parameters rather than by flow measurements. Generally, only one significant flow contribution was found within a single producing zone of a well. All flow contributions within a single producing zone were integrated to give a single TDS value for that producing zone. More than one flow contribution was detected within a single producing zone in only a few cases.

GENERAL INTERPRETATION

Producing zone 3 is associated with thick discrete gray to blue crystalline dolomite beds within dolomitic limestones. No attempt was made to contour either the water quality or depth to producing zone 3, due to the lack of control points penetrating this zone.



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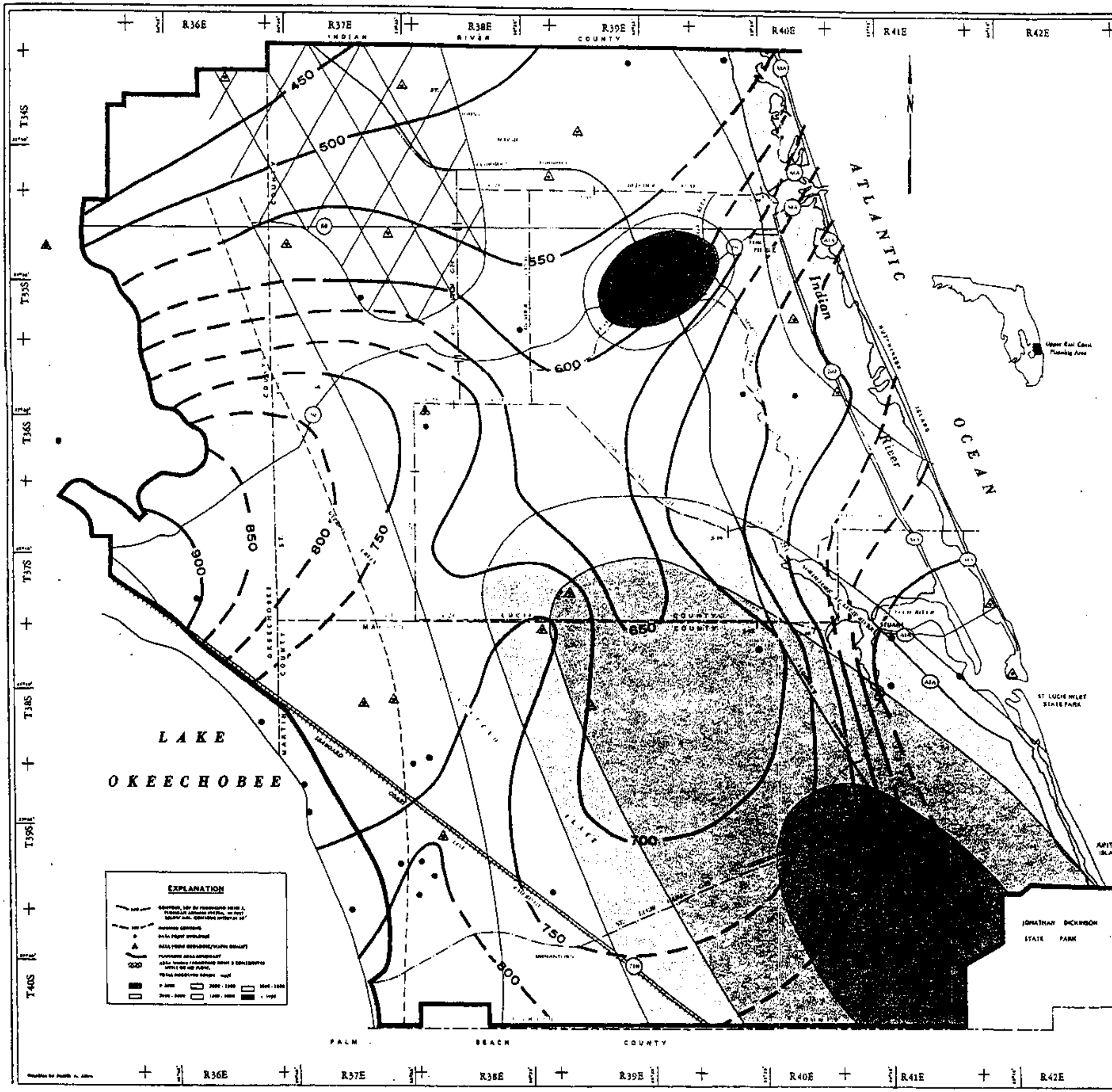

TOP OF PRODUCING ZONE 2 AND ACCOMPANYING WATER QUALITY FLORIDAN AQUIFER SYSTEM UPPER EAST COAST PLANNING AREA

By:
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Prepared By:
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

1979

INTRODUCTION

Throughout the Upper East Coast Planning Area (UECPA) contributing intervals within the Floridan aquifer system were found to be stratigraphically confined to unique rock units with the percent space contribution to the open borehole varying greatly. In the UECPA the Floridan aquifer system consists of a number of producing zones of different hydrologic properties separated by semi-permeable zones in a sequence of Lower Oligocene, Upper and Middle Eocene limestone. The base of the Floridan aquifer system could not be defined because the total depths of wells used for data collection limited depth of exploration.

METHODOLOGY

Data collected in the compilation of this map include geologic descriptions of well cuttings from nine control wells and borehole geophysical logs from 36 wells. Twenty-two geologic logs collected from other agencies were also examined.

Borehole geophysical surveys used to determine contributing intervals in the open borehole include borehole fluid resistivity/temperature logs collected from 36 wells and corrected flow meter logs calculated for 17 wells. Natural gamma ray, neutron porosity and acoustic logs were used to tie the geology and stratigraphy to these intervals within the Floridan aquifer system.

The water quality observed at the wellhead of a Floridan well in the UECPA is a composite of the formational water quality of the various producing zones penetrated by the open portion of the borehole. Borehole geophysical methods were used to determine flow and water quality in the borehole. A mass balance technique requiring borehole flow and borehole water quality above and below a producing zone was used to estimate total dissolved solids (TDS) of the water in each producing zone. Relative borehole flow at any point in the well was calculated from the flow meter log and the caliper log in the following manner.

$$Q = Av$$

Where,

Q = flow (in relative units of $cps \cdot in^2$) in the borehole.
A = area (in^2) of the borehole assuming circular borehole conditions.
v = velocity (cps) of the borehole fluid.

Corrected flow logs were composed of constant depth intervals of two feet. A typical caliper log, flow meter log, and computed flow log are shown below. A best fit line is drawn through constant flow portions of the flow log. Where a producing zone contributes water flow increases reflecting the cumulative flow of all producing zones below the point of measurement. The relative flow contribution of each producing zone is the ratio of the difference in flow across the producing zone to the total flow of the well.

Fluid resistivity logs were used to estimate borehole water quality for most wells.

Fluid resistivity is related to specific conductance by the following equation:

$$C = \frac{10{,}000}{R}$$

Where,

C = specific conductance in micromhos/cm
R = fluid resistivity in ohm meters

Fluid resistivity data used in this study were compensated for fluid temperature at 25°C.

Wellhead water sample analyses from all monitoring wells were used to calculate the following regression equation for TDS and specific conductance.

$$TDS = .631 \times C + 57.5$$

Where,

TDS = total dissolved solids in mg/l

A linear correlation coefficient of 0.82 was found for TDS and specific conductance.

The following mass balance equation was used to estimate TDS values for the water of each producing zone.

$$TDS_{zone} = \frac{Q_A TDS_A - Q_B TDS_B}{(Q_A - Q_B)}$$

Where,

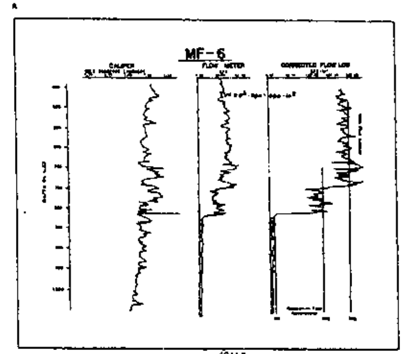
Q_A + TDS_A are the borehole flow and borehole fluid TDS value, respectively, above the producing zone.
Q_B + TDS_B are the borehole flow and borehole fluid TDS value, respectively, below the producing zone.

Tops and bottoms of each producing zone were defined by geologic parameters rather than by flow measurements. Generally, only one significant flow contribution was found within a single producing zone of a well. All flow contributions within a single producing zone were integrated to give a single TDS value for that producing zone. More than one flow contribution was detected within a single producing zone in only a few cases.

GENERAL INTERPRETATION

Producing zone 2 is correlated with a lithologic interface between a white, very clean microfossiliferous limestone above, and a less pure chalky limestone with a few fossils below. The top of producing zone 2 ranges from 450 ft. msl in northwest St. Lucie County to over 950 ft. msl in southeast Martin County. Thickness of producing zone 2 averages approximately 30 ft.

Producing zone 2 does not significantly contribute to flow in wells in the northwest sector of the planning area. The reason for the lack of meaningful contribution of water has not been determined. A broad zone of poor quality water extends from northwest to southeast across the UECPA. Relatively good quality water occurs in producing zone 2 in the western portion of the planning area. A small area of relatively good quality water also exists west of Fort Pierce. Calculated TDS values of producing zone 2 range from 910 mg/l in northwestern Okeechobee County to 3010 mg/l in southeastern Martin County.



SCALE
0 1 2 3 4 MILES

GENERALIZED HYDROGEOLOGIC CROSS SECTIONS

UPPER EAST COAST PLANNING AREA

By:
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INTRODUCTION

The Floridan aquifer first defined by Parker (includes, "parts or all of the Middle Eocene (Ocala Limestone), Oligocene (Suwannee Limestone), and Miocene (Tampa Limestone) and permeable parts of the Hawthorn Formation that are in hydrologic contact with the rest of the aquifer." (Parker, et al., 1955). In the Upper East Coast Planning Area (UECPA) (Index map shown) the Floridan aquifer system consists of a number of producing zones of different hydrologic properties separated by semi-permeable zones in a sequence of lower Oligocene (unknown, possibly Suwannee Limestone), and Upper and Middle Eocene (Ocala Limestone and Upper Avon Park Formation) carbonate sediments[1]. The base of the Floridan aquifer system could not be defined as total depths of wells used for data collection limited the depth of exploration.

METHODOLOGY

Data used in the construction of these general hydrogeologic sections includes geologic descriptions of well cuttings from OKF-29, SLF-5, SLF-14, SLF-23, OKF 24, MF-3, MF-30 and PBF-1 and borehole geophysical logs from all wells shown in the three hydrogeologic cross-sections. Geophysical logs of 37 wells and geologic logs for 30 wells collected during this and other studies were examined and integrated into the preparation of plates 10A and B.

Borehole geophysical surveys useful in determining water contributing intervals in the open borehole included borehole fluid resistivity temperature logs collected from 24 wells and corrected flow meter logs calculated for 17 wells. Natural gamma ray, neutron porosity and electric logs served to tie the geology and stratigraphy to contributing intervals within the Floridan aquifer system.

GENERAL HYDROGEOLOGY

Throughout the UECPA the contributing intervals within the Floridan aquifer system were consistently found to be stratigraphically confined within four separate producing zones. Cross sections shown reflect the general regional hydrogeologic framework from land surface through the shallow aquifer system, the major confining zone and the Floridan aquifer system.

In the UECPA the shallow aquifer system consists of white to tan and brown unconsolidated quartz sand, white to brown sandy and shelly well cemented limestone with increasing amounts of phosphorite and gray to light green clay towards the base. The thickness of the relatively high water yielding zone in the shallow aquifer system varies from less than 50 ft. to more than 250 ft. The shallow aquifer system is separated from the Floridan aquifer system by more than 300 ft. of light gray to olive green sandy, shelly, phosphatic plastic clay.

The top of the Floridan aquifer system (producing zone 1) is correlated with a contributing interval found within a tan sandy limestone, poorly cemented, containing silt size phosphorite. This phosphorite may cause the high intensity natural gamma kick observed throughout the area which marks the top of the system. The top of producing zone 2 is found to correlate with a lithologic interface between a white, very clean coquina and friable microfossiliferous limestone above, and a less pure chalky limestone with very few fossils below. This change in lithology is also observed on the natural gamma ray survey with the upper rock type having a lower radiation level than that of the lower rock type. Producing zone 2 grades into a light gray to tan, hard, well cemented microcrystalline limestone or dolostone. The lower producing zones (zones 3 and 4) were found to correlate with relatively thick discrete beds of gray to blue crystalline dolomite within massive limestone beds.

[1] Classification and nomenclature of geologic units conform to the usage of the Florida Bureau of Geology.

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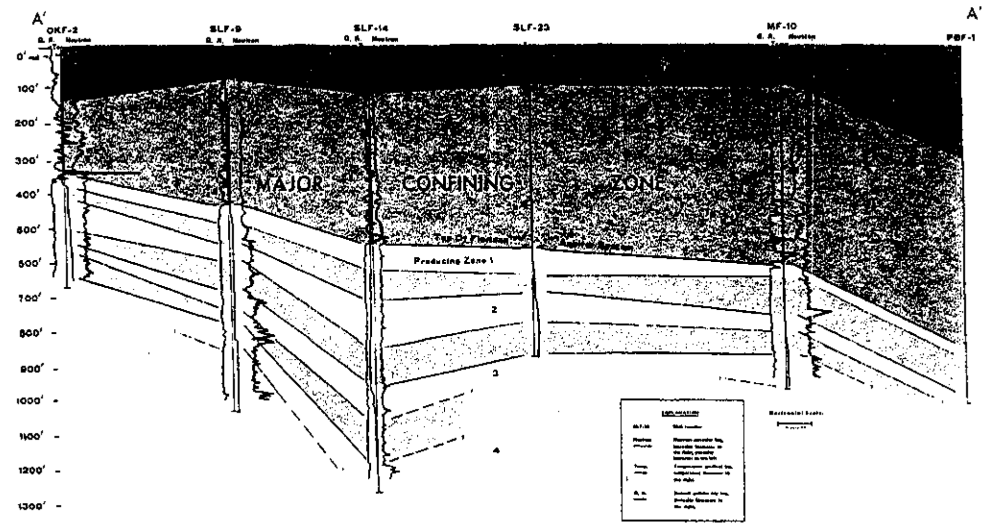
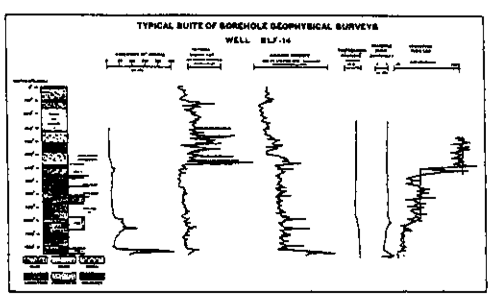
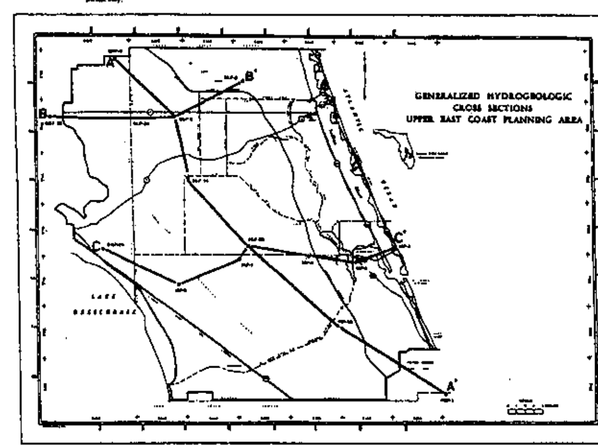




GENERAL HYDROGEOLOGY – UPPER EAST COAST PLANNING AREA

APPROXIMATE THICKNESS	SERIES	FORMATION	GENERAL LITHOLOGY	GEOPHYSICAL SURVEY CHARACTERISTICS	AQUIFER	CHARACTERISTIC FAUNAL ASSEMBLAGES
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Shallow Aquifer System	—
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Confining Zone	—
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Top of Floridan Aquifer System; Producing Zone 1	[illegible]
[illegible]	[illegible]	Ocala Limestone UPPER / LOWER	[illegible]	[illegible]	Semi-Permeable Zone; Producing Zone 2	[illegible]
[illegible]	[illegible]	Avon Park Formation	[illegible]	[illegible]	Semi-Permeable Zone; Producing Zone (s) 3 & 4	[illegible]

[illegible]



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